

## CLAIMS:

1. An isolated bacterium that has a greater than 75% reduction in hydrogenase activity relative to a wild type strain.
2. The isolated bacterium of claim 1 wherein the strain comprises a mutation of a NiFe hydrogenase gene, wherein the mutation disrupts the encoded NiFe hydrogenase enzyme's ability to oxidize H<sub>2</sub>.
3. The isolated bacterium of claim 2 wherein the strain comprises a mutation to each of the NiFe hydrogenase genes present in the genome of the strain, wherein the mutations prevent the expression of a functional NiFe hydrogenase protein.
4. The isolated bacterium of claim 1 wherein the strain is incapable of expressing a functional NiFe hydrogenase protein.
5. The isolated bacterium of claim 1 wherein the bacterium selected from the group consisting of *Salmonella*, *Helicobacter*, *E. coli*, *Shigella*, and *Campylobacter*.
6. The isolated bacterium of claim 3 wherein the bacterium is selected from the group consisting of *Salmonella typhimurium*, *Salmonella typhi*, *E. coli* 0157, *Shigella flexneri*, *Shingella sonnei*, and *Campylobacter jejuni*.
7. An antigenic composition comprising an isolated bacterium of claim 3 and a pharmaceutically acceptable carrier.
8. The antigenic composition of claim 7 further comprising an adjuvant.
9. The antigenic composition of any of claims 7 wherein the pharmaceutically acceptable carrier comprises water.
10. The antigenic composition of claim 7 in the form of a frozen or lyophilized powder.
11. A method of inducing an immune response in a mammal against a pathogenic bacterium said method comprising the step of  
administering to said mammal a composition comprising live bacterium, wherein the bacterium has been modified to prevent the expression of a functional NiFe hydrogenase protein.

12. The method of claim 11 wherein the bacterium is selected from the group consisting of *Salmonella typhimurium*, *Salmonella typhi*, *Helicobacter hepaticus*, *E. coli* 0157, *Shigella flexneri*, *Shingella sonnei*, and *Campylobacter jejuni*.

13. The method of claim 12 wherein the modification comprises a mutation to each of the NiFe hydrogenase genes present in the genome of the bacterium

14. A method of protecting a mammalian species against an infection with pathogenic *Salmonella*, *E. coli*, *Shigella*, or *Campylobacter*, said method comprising the step of administering to the subject a live bacterium, selected from the group consisting of *Salmonella*, *E. coli*, *Shigella*, and *Campylobacter*, wherein the bacterium has been modified to prevent expression of a functional NiFe hydrogenase protein.

15. The method of claim 14 wherein the live modified bacterium is administered orally at a dose of about  $10^4$  to about  $10^8$  cfu.

16. The method of claim 14 wherein the modification comprises a deletion mutation to each of the NiFe hydrogenase genes present in the genome of the bacterium.

17. The method of claim 16 wherein the mammalian species is protected from a *Salmonella* infection, said method comprising administering live *Salmonella* wherein each of the NiFe hydrogenase genes present in the genome of the bacterium has been mutated to prevent expression of a functional NiFe hydrogenase protein.